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Filed: April 7, 2000	)	
	)	
For: CEMENTED CARBIDE INSERT	)	

#41

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CLAIM FOR CONVENTION PRIORITY

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The benefit of the filing date of the following prior foreign application in the following foreign country is hereby requested, and the right of priority provided in 35 U.S.C. § 119 is hereby claimed:

Patent Application No. 9901244-5

Filed: April 8, 1999

In support of this claim, enclosed is a certified copy of said prior foreign application. Said prior foreign application is referred to in the oath or declaration. Acknowledgment of receipt of the certified document is requested.

Respectfully submitted,

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PATENT- OCH REGISTRERINGSVERKET

Patentavdelningen

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Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

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Cemented carbide insert

The present invention relates to a coated cemented carbide cutting tool insert particularly useful for turning operations in steels or stainless steels, especially suited for operations with high demands regarding both toughness and wear resistance properties of the insert. The cemented carbide insert has surface zones with element compositions differing from the bulk composition giving simultaneously an excellent toughness performance and good resistance to plastic deformation.

High performance cutting tools must nowadays possess high wear resistance, high toughness properties and good resistance to plastic deformation. Improved toughness behaviour of a cutting insert can be obtained by increasing the WC grain size and/or by raising the overall binder phase content, but such changes will simultaneously result in significant loss of the plastic deformation resistance.

Methods to improve the toughness behaviour by introducing thick essentially gamma phase free and binder phase enriched surface zone with a thickness of about 20-40 µm on the inserts by a so called gradient sintering techniques have been known for some time e.g. US 4,277,283, US 4,497,874, US 4,548,786, US 4,640,931, US 5,484,468, US 5,549,980, US 5,649,279, US 5,729,823. The characteristics of these patents are that the surface zone is depleted of gamma phase and binder phase enriched.

It has now surprisingly been found that by using an optimized composition of the gamma phase i.e. a gamma phase consisting essentially of only TaC and TiC in addition to WC, by keeping the ratio between the elements Ta and Ti within specific limits and a W-alloyed binder phase, the toughness properties of the gradient sintered cutting inserts can be significantly improved without any loss of plastic deformation resistance.

According to the present invention there is now provided a coated cemented carbide insert with a 5-50 µm thick, preferably 10-40 µm, thick essentially gamma phase free and

binder phase enriched surface zone with an average binder phase content (by volume) in the range 1.2-2.0 times the bulk binder phase content. The gamma phase consist essentially of TaC and TiC and to some extent of WC that dissolves into the gamma during sintering. The ratio Ta/Ti is between 1.0 and 4.0. The gamma phase content of the elements Nb, Zr and Hf is on the impurity level.

The binder phase is highly W-alloyed. The content of W in the binder phase can be expressed as a

CW-ratio = M_S /(wt-% Co · 0.0161) where

M_S is the measured saturation magnetisation of the cemented carbide body in kA/m and wt-% Co is the weight percentage of Co in the cemented carbide. The CW-ratio takes a value <=1 and the lower the CW-ratio is the higher is the W-content in the binder phase. It has now been found according to the invention that an improved cutting performance is achieved if the CW-ratio is in the range 0.75-0.95.

The present invention is applicable to cemented carbides with a composition of 5-12, preferably 6-9, weight percent of binder phase consisting of Co, and 3-11, preferably 4-7, weight percent TaC + TiC and a balance WC. The Nb content should not exceed 0,1 weight percent. The weight ratio Ta/Ti should be 1.0-4.0. The WC has an average grain size of 1.0 to 4.0 μm, preferably 1.5 to 3.0 μm. The cemented carbide body may contain small amounts, <1 volume-%, of η-phase (M_6C).

Inserts according to the invention are further provided with a coating consisting of basically 3-12 μm columnar TiCN-layer followed by a 1-8 μm thick Al_2O_3-layer deposited e.g. according to any of the patents US 5,766,782, US 5,654,035, US 5,674,564, US 5,702,808 preferably with a κ-Al_2O_3-layer.

By applying coatings with different thickness on the cemented carbide body according to the invention, the property of the coated insert can be optimised to suit specific cutting conditions. In one embodiment, a cemented carbide insert produced according to the invention is provided with a coating consisting of: 6 μm TiCN, 5 μm Al_2O_3 and 1 μm TiN. This coated insert is particularly suited for operation in steel. In another embodiment, a cemented carbide insert produced

according to the invention is provided with a coating consisting of: 8 µm TiCN, 2 µm Al_2O_3 and 1 µm TiN. This coating is particularly suited for cutting operations in stainless steels.

The invention also relates to a method of making cutting inserts comprising a cemented carbide substrate consisting of a binder phase of Co, WC and a gamma phase from the elements Ta and Ti with a binder phase enriched surface zone essentially free of gamma phase and a coating. A powder mixture containing 5-12, preferably 6-9, weight percent of binder phase consisting of Co, and 3-11, preferably 4-7, weight percent TaC + TiC and a balance WC with an average grain size of 1.0 - 4.0 µm, preferably 1.5 - 3.0 µm is prepared. The Nb content should not exceed 0.1 weight percent. The weight ratio Ta/Ti should be 1.0-4.0. Well-controlled amounts of nitrogen have to be added either through the powder as carbonitrides or/and added during the sintering process via the sintering gas atmosphere. The amount of added nitrogen will determine the rate of dissolution of the cubic phases during the sintering process and hence determine the overall distribution of the elements in the cemented carbide after solidification. The optimum amount of nitrogen to be added depends on the composition of the cemented carbide and in particular on the amount of cubic phases and varies between 0.6 and 2.0% of the weight of the elements Ti and Ta. The exact conditions depend to a certain extent on the design of the sintering equipment being used. It is within the purview of the skilled artisan to determine whether the requisite surface zone of the cemented carbide have been obtained and to modify the nitrogen addition and the sintering process in accordance with the present specification in order to obtain the desired result.

The raw materials are mixed with pressing agent and possibly W such that the desired CW-ratio is obtained and the mixture is milled and spray dried to obtain a powder material with the desired properties. Next, the powder material is compacted and sintered. Sintering is performed at a temperature of 1300-1500°C, in a controlled atmosphere of about 50 mbar followed by cooling. After conventional post sintering

treatments including edge rounding a hard, wear resistant coating according to above is deposited by CVD- or MT-CVD-technique.

Example 1

A.) Cemented carbide turning inserts of the style CNMG 120408-PM with the composition 7,5 wt% Co, 3,8 wt% TaC, 1,9 wt% TiC and 0,40 wt% TiN and balance WC with an average grain size of 2.0 µm were produced according to the invention. The nitrogen was added to the carbide powder as TiCN. Sintering was done at 1450 °C in a atmosphere consisting of Ar at a total pressure of about 50 mbar.

Metallographic investigation showed that the produced inserts had a cubic-carbide-free zone of 25 µm. Fig.1 shows a plot of the Co enrichment near the surface measured by image analysis technique. The Co is enriched to a peak level of 1,3 times the bulk content. Magnetic saturation values were recorded and used for calculating CW-values. An average CW-value of 0.89 was obtained.

After conventional pre coating treatment like edge honing, cleaning etc. the inserts were coated in a CVD-process comprising a first coated with a thin layer < 1 µm of TiN followed by 6 µm thick layer of TiCN with columnar grains by using MTCVD-techniques (process temperature 850 °C and CH_3CN as the carbon/nitrogen source). In a subsequent process step during the same coating cycle, a 5 µm thick κ-Al_2O_3 layer was deposited according to patent US 5,644,564. On top of the κ-Al_2O_3 layer a 1,0 µm TiN layer was deposited. The coated insert were brushed in order to smoothly remove the TiN coating from the edge line.

B.) Cemented carbide turning inserts of the style CNMG 120408-PM with the composition 7,5 wt% Co, 2,9 wt% TaC, 1,9 wt% TiC, 0,5 wt% NbC and 0,40 wt% TiN and balance WC with an average grain size of 2.0 µm were produced. The inserts were sintered in the same process as **A.** Metallographic investigation showed that the produced inserts had a cubic-carbide-free zone of 25 µm. Magnetic saturation values were recorded and used for calculating CW-values. An average CW-

value of 0.89 was obtained. The inserts were subject to the same pre-coating treatment as **A**, coated in the same coating process and also brushed in the same way as **A.**

Example 2

Inserts from **A** were tested and compared with inserts from **B** with respect to toughness in a longitudinal turning operation with interrupted cuts.

Material: Carbon steel SS1312.

Cutting data:

Cutting speed = 120 m/min

Depth of cut = 1,5 mm

Feed = Starting with 0,15 mm and gradually increased by 0,10 mm/min until breakage of the edge

10 edges of each variant were tested

Inserts style: CNMG120408-PM

Results:

	Mean feed at breakage
Inserts A	0,51 mm/rev
Inserts B	0,25 mm/rev

Example 3

Inserts from **A** and **B** were tested with respect to resistance to plastic deformation in longitudinal turning of alloyed steel (AISI 4340).

Cutting data:

Cutting speed= 160 m/min

Feed= 0,7 mm/rev.

Depth of cut= 2 mm

Time in cut= 0,50 min

The plastic deformation was measured as the edge depression at the nose of the inserts.

Results:

	Edge depression, μm
Insert A	61
Insert B	61

Examples 2 and 3 show that inserts A according to the invention exhibit much better toughness in the combination

with the same plastic deformation resistance in comparison to inserts B according to prior art.

Claims

1. A cutting tool insert for machining of steel comprising a cemented carbide body and a coating c h a r a c t e r i s e d in that said body consists of WC, 5-12, preferably 6-9, wt-% Co and 3-11, preferably 4-7, wt-% of cubic carbides of metals Ta, Ti and W and that the amount of Zr, Nb, Hf is less or equal to 0.1 weight percent and that the ratio Ta/Ti is 1-4 and that the Co-binder phase is highly alloyed with W with a CW-ratio of 0.75-0.95 and that the said cemented carbide body has a binder phase enriched and essentially gamma phase free surface zone of a thickness of 5-50 μm.

2. A cutting tool insert according to claim 1 c h a r a c t e r i s e d in that the thickness of the surface zone is within 10-40 μm.

3. A cutting tool insert according to claim 1 or 2 c h a r a c t e r i s e d in that said coating comprises a 3-12 μm columnar TiCN-layer followed by a 2-12 μm thick Al_2O_3-layer.

4. A cutting tool insert according to previous claims c h a r a c t e r i s e d in that the said Al_2O_3-layer is κ-Al_2O_3.

5. A cutting tool insert according to any of claim 1-4 c h a r a c t e r i s e d in an outermost layer of TiN.

6. A cutting tool insert according to any of the previous claims c h a r a c t e r i s e d in that the TiN layer in the edge line is removed by brushing or by blasting.

7. A cutting tool insert according to any of claim 1-6 c h a r a c t e r i s e d in that the average WC-grain size is within 1.0-4.0 μm.

8. Method of making a cutting insert comprising a cemented carbide substrate with a binder phase enriched surface zone and a coating, said substrate consisting of a binder phase of Co, WC and a cubic carbonitride phase, said binder phase enriched surface zone being essentially free of said cubic carbonitride phase and with an essentially constant thickness around the insert c h a r a c t e r i s e d in forming a powder mixture containing WC, 5-12, preferably 6-9, weight percent Co, and 3-

11, preferably 4-7, weight percent cubic carbides of the metals Ti and Ti whereby N is added in an amount of between 0.6 and 2.0% of the weight of the elements Ti and Ta,

mixing said powders with pressing agent and possibly W such that the desired CW-ratio is obtained

milling and spray drying the mixture to a powder material with the desired properties

compacting and sintering the powder material at a temperature of 1300-1500°C, in a controlled atmosphere of about 50-mbar followed by cooling

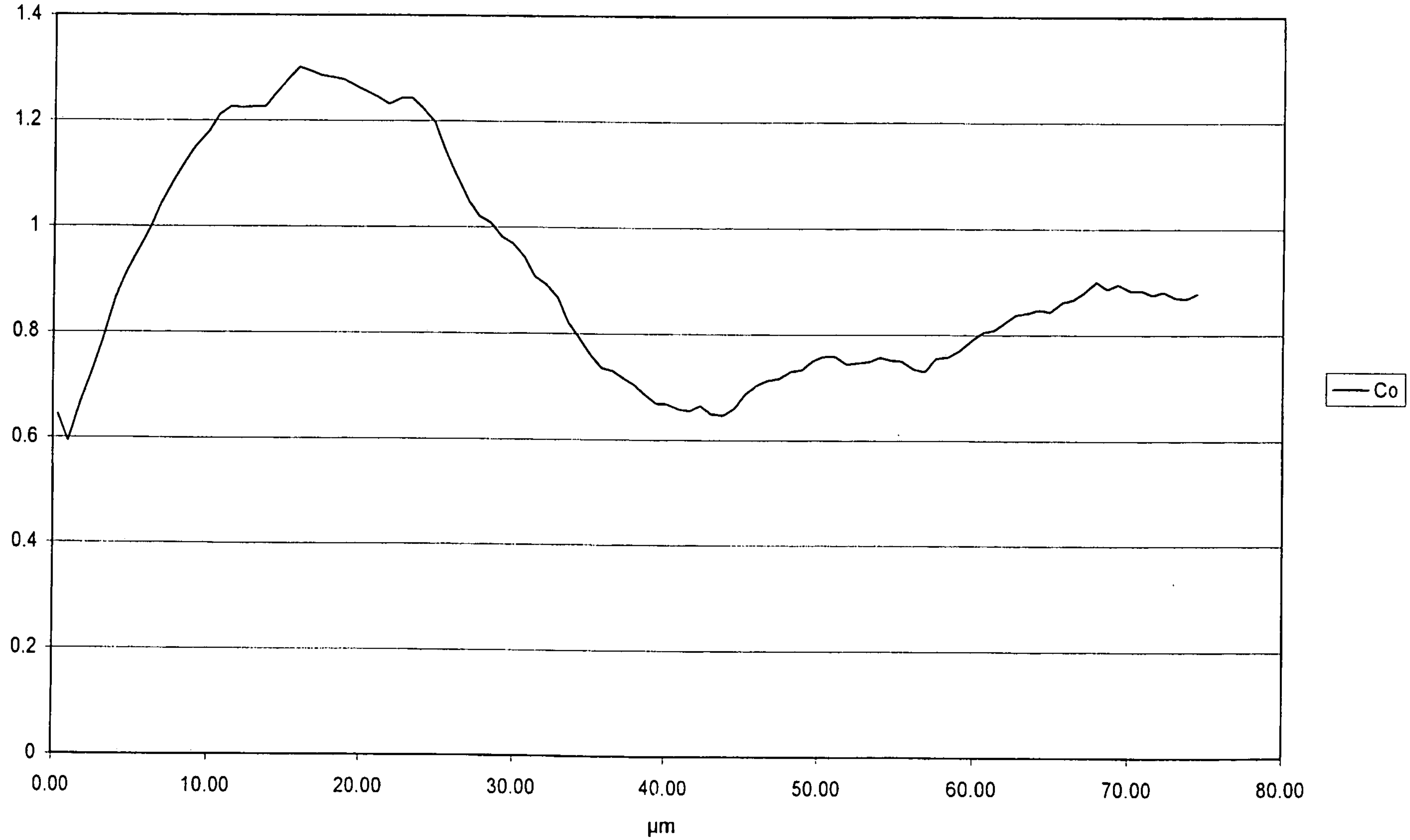
applying conventional post sintering treatments including edge rounding and

applying a hard, wear resistant coating by CVD- or MT-CVD-technique.

Abstract

The present invention relates to a cutting tool insert for machining of steel comprising a cemented carbide body and a coating. The cemented carbide body consists of WC, 5-12 wt-% Co and 3-11 wt-% cubic carbides of metals Ta, Ti and W. The amount of Nb should be below 0.1 wt-%. The ratio Ta/Ti is 1-4. The Co-binder phase is highly alloyed with W with a CW-ratio of 0.75-0.95. Finally the cemented carbide body has a binder phase enriched and essentially gamma phase free surface zone of a thickness of 5-50 µm.

Fig.1



1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
µm
Co